

I-STEM

EDUCATION INITIATIVE

Science, Technology, Engineering, and Mathematics Education | University of Illinois at Urbana-Champaign

I-STEM EDUCATION INITIATIVE ANNUAL REPORT

January 2010



 ILLINOIS

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From the Desk of the I-STEM Director

After a tremendously busy first year, it certainly appears that I-STEM was created at “the right place at the right time.” Issues of STEM preparedness, workforce development, and global competitiveness loom large in local, state, and federal arenas. Illinois faculty, staff, and students, our external education and business partners, and peer institutions across the nation are all eager for new opportunities. Our collective desire is to increase students’ interest and engagement in STEM disciplines, create accessible, high-quality STEM programs at all levels, improve the magnitude and quality of our STEM workforce, including teachers, and advocate for policies and funding to support STEM education in Illinois and the nation at large. Much of what we have done in the first year of I-STEM is to bring together these interest groups, explore common interests and promote collaboration, and define a program of work around our shared goals. The momentum continues to increase as we identify more and more areas of synergy, opportunities for federal and state support, and exciting partners. We are beginning to see the benefits of increased collaboration and entrepreneurship in STEM education and are hopeful that the energy and impact will continue to grow in 2010!



*Lizanne DeStefano
Director*



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I-STEM Campus Partners



Colleges and Schools

- College of Agricultural, Consumer, and Environmental Sciences
- College of Applied Health Sciences
- Institute of Aviation
- College of Business
- College of Education
- College of Engineering
- College of Fine and Applied Arts
- Division of General Studies
- Graduate College
- School of Labor and Employment Relations
- College of Law
- College of Liberal Arts and Sciences
- Graduate School of Library and Information Sciences
- College of Media
- College of Medicine
- School of Social Work
- College of Veterinary Medicine

Research Units

- Beckman Institute for Advanced Science and Technology
- Center for Education in Small Urban Communities
- Division of Biomedical Sciences
- Institute for Genomic Biology
- Office for Mathematics, Science, and Technology Education
- NCSA (National Center for Super-Computing Applications)
- University of Illinois Extension—4H



I-STEM External Partners

External Partners

- American Chemical Society
- American Physics Society
- American Society of Materials
- Association of Public Land-grant Universities (APLU)
- Caterpillar Foundation
- Chicago Community Trust (CCT)
- Department of Commerce and Economic Opportunity (DCEO)
- Illinois Biotechnology Industry Organization (iBIO)
- Illinois Math and Science Academy (IMSA)
- John Deere Foundation
- Office of the Governor, State of Illinois
- Physics Teacher Education Coalition
- Science Olympiad

Local Partners

- Champaign Unit 4 School District
- Urbana School District 116
- Thornton Community Unit High School District 205
- Chicago Public Schools
- University Laboratory High School
- Campus Middle School for Girls
- Champaign-Urbana Schools Foundation





I-STEM's vision is to foster accessible, effective STEM teaching and learning at local, state, and national levels, thereby preparing a highly able citizenry and STEM workforce to tackle pressing global challenges.

SCIENCE OLYMPIAD 2009
KENNEDY JUNIOR HIGH SCHOOL

BE NICE TO NERDS. CHANCES ARE,
YOU'LL BE WORKING FOR ONE.
-BILL GATES

- K. Bellamkonda
- L. Koppa
- N. Lindquist
- S. Zhou
- G. Ng
- A. Holtzer
- H. Jin
- C. Wang
- S. Wang
- K. Lee
- G. Chandra
- K. Suh
- S. Wagner
- K. Lee
- S. Liu
- Mr. Cove
- Ms. Rutherford

I-STEM's Mission & Goals

I-STEM Education Initiative (the Illinois Science, Technology, Engineering and Mathematics Education Initiative) began operation on January 20, 2009. I-STEM—a campus coalition grounded in education and led by the Office of the Chancellor—counts all academic units and major campus research units on the University of Illinois at Urbana-Champaign campus (*Illinois*) as partners. I-STEM's mission is to improve the access, quality, and efficiency of STEM education activities on the *Illinois* campus and throughout the state.

Why a campus focus on STEM education?

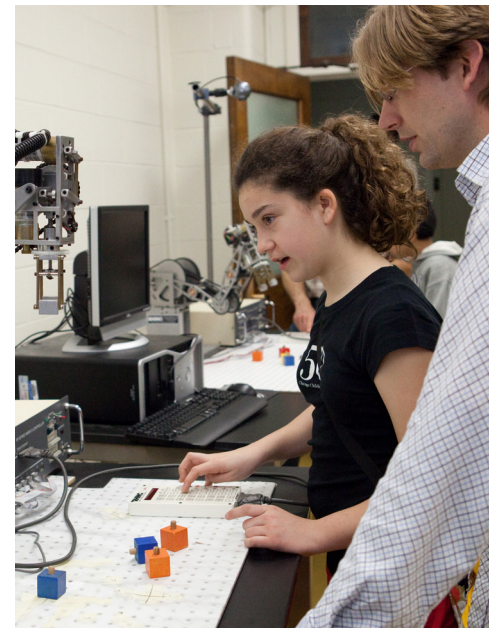
Our world increasingly relies on science and technology to solve some of today's most intractable problems. As noted in the 2007 National Academy of Sciences report, *Rising Above the Gathering Storm*, U.S. student interest and performance in science, technology, engineering, and mathematics (STEM) fields is in decline. Perhaps at no time in our nation's history has a strong, comprehensive system of education been so essential. As challenges mount in such areas as national defense, climate change, health, energy, economic growth, food safety and accessibility, and environmental protection, so does the demand for highly able scientists, engineers, and health professionals. As the flagship campus of one of the nation's premier land-grant research universities, *Illinois* is committed to playing an active role in the improvement of STEM education at all levels.

I-STEM is organized around four primary goals, which are:

- ▶ **Goal 1: Facilitate P–16 STEM Education Outreach.** Cultivate sustained, coordinated preschool through undergraduate partnerships to engage students in STEM experiences early and consistently, involving university faculty and students to meet STEM education challenges.
- ▶ **Goal 2: Improve STEM Teacher Training and Professional Development Quality.** Revitalize STEM teacher preservice education, induction, and professional development programs that attract and prepare a diverse group of P–16 STEM teachers and promote their effectiveness, retention, lifelong learning, and continued involvement in research.
- ▶ **Goal 3: Foster Undergraduate and Graduate STEM Education Reform.** Stimulate accessible, engaging undergraduate and graduate STEM programs and research experiences to promote interest and success in STEM fields, including teaching, for diverse students.
- ▶ **Goal 4: Shape Policy and Advocate for STEM Education.** Stimulate partnerships with Illinois business and industry, government agencies, educational institutions, and professional associations to understand the STEM pipeline, mainline and workforce development needs, opportunities, and challenges and to serve as advocates within the state.



I-STEM's mission is to improve the access, quality, and efficiency of STEM education activities on the Illinois campus and throughout the state.



Above: Science Olympiad participant on campus tour. Opposite page (p. iv): Contestants preparing exhibit for Science Olympiad competition.



During its first year of operation, I-STEM performed a variety of activities to establish itself as a visible, active unit on campus.



Seminar room in new offices at 704 South Sixth Street, Champaign.

Start-up activities.

During its first year of operation, I-STEM performed a variety of activities to establish itself as a visible, active unit on campus. Some of these initial steps included:

1. Moving into its permanent location at 704 S. Sixth Street on July 20, 2009. In the heart of campus town, the new facility is in a central campus location and has adequate space to provide easy access for meetings of its constituents.
2. Holding more than 40 interviews and focus groups with key campus and external stakeholders to acquaint them with I-STEM and gain their input on goals, priorities, and ways I-STEM could best serve both campus units and external entities.
3. Assembling internal and external advisory bodies.
4. Identifying STEM education coordinators in each unit to serve as liaisons with I-STEM for P-16 outreach.
5. Forming an I-STEM Undergraduate and Graduate Education Working Group. At least one faculty representative from each STEM department on campus was invited to participate.
6. Designing and launching a website and suite of informational materials, including handouts, interactive directories, and a campus-wide listserv.

Communication Resources

- **I-STEM Website.** I-STEM's website incorporates information from a variety of sources to produce and maintain focused, current information on campus STEM education activities, including P-16 outreach, for both internal and external audiences. This includes a campus-wide Directory of Externally-Funded Projects.
url: <http://www.istem.illinois.edu>
- **I-STEM-News Listserv.** Provides campus faculty and staff with announcements of STEM education funding opportunities and announces I-STEM seminars, meetings, and workgroup activities.
url: listserv@listserv.illinois.edu
- **I-STEM Affiliates Directory.** Published on our website, the directory provides important visibility to individuals involved in STEM education research, programming, training, outreach, and policy activities from all parts of campus—aspects of their work that are not comprehensively featured elsewhere.
url: http://www.istem.illinois.edu/resources/affiliates_A.html
- **Public Engagement Portal (PEP).** PEP includes campus STEM education outreach programs as part of its broader role to highlight campus outreach activities in all domains and across university-related public entities.
url: <http://engage.illinois.edu/>

I-STEM ADVISORY BODIES

Campus Council of Deans

- Robert Hauser, Dean, Agricultural, Consumer, and Environmental Sciences
- Tanya Gallagher, Dean, Applied Health Sciences
- Tom Emanuel, Director of Academic Affairs, Institute of Aviation
- Larry DeBrock, Dean, Business
- Mary Kalantzis, Dean, Education
- Adesida Ilesanmi, Dean, Engineering
- Robert Graves, Dean, Fine and Applied Arts
- Julian Parrott, Director, General Studies
- Joel Cutcher-Gershenfeld, Dean, Labor & Employment Relations
- Bruce Smith, Dean, Law
- Ruth Watkins, Dean, Liberal Arts and Sciences
- John Unsworth, Dean, Library and Information Science
- Walt Harrington, Dean, Media
- Bradford Schwartz, Dean, Medicine
- Wynne Korr, Dean, Social Work
- Herbert Whiteley, Dean, Veterinary Medicine

Campus Administration

- Richard Wheeler, Acting Vice-Chancellor for Academic Affairs
- Ravishankar Iyer, Interim Vice-Chancellor for Research
- Steven Sonka, Interim Vice-Chancellor for Public Engagement
- Debasish Dutta, Dean, Graduate College
- Jimmy Hsia, Associate Dean, Graduate Administration

Campus Interdisciplinary Units

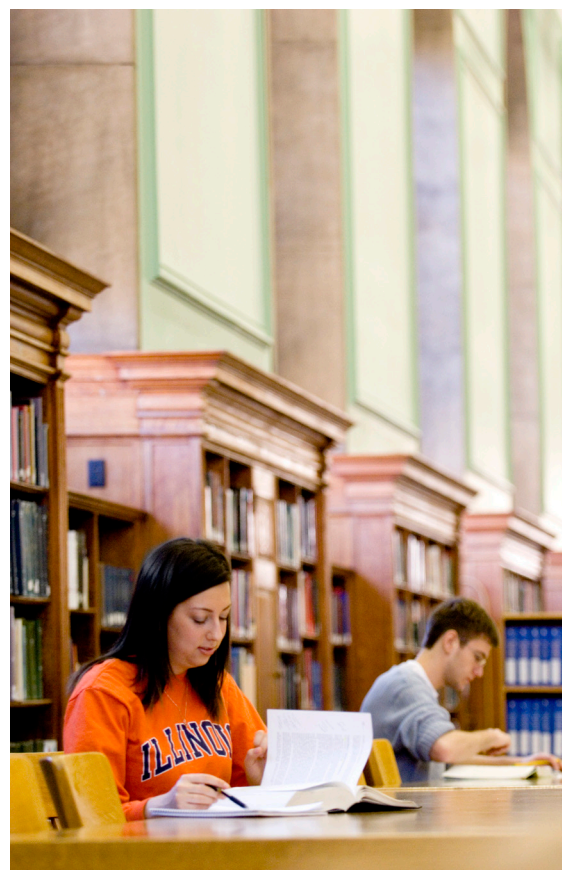
- Lawrence Shook, Director, Division of Biomedical Sciences
- Harris Lewin, Director, Institute for Genomic Biology
- Tamer Basar, Director, Beckman Institute
- Thomas Dunning, Director, NCSA

I-STEM External Advisory Board

- Jason Tyszko, Deputy Chief of Staff, Department of Commerce and Economic Opportunity, and Office of the Governor, State of Illinois
- Max McGee, President, Illinois Mathematics & Science Academy
- Arthur Culver, Superintendent, Champaign Unit 4 School District
- Preston Williams, Superintendent, Urbana School District 116
- Gail Rost, Executive Director, Champaign Urbana Schools Foundation

I-STEM Corporate Advisory Board

- Caterpillar Foundation
- Motorola Foundation
- Abbott Laboratories
- Boeing Company
- John Deere Foundation
- State Farm Foundation



A young woman with long dark hair and glasses, wearing a red shirt, is holding a black and white French Bulldog puppy. The puppy is looking towards the camera and has a purple tag on its collar. The background is a blurred indoor setting with fluorescent lights.

I-STEM is partnering with state and national organizations, such as Science Olympiad, to foster interest in science among Illinois K–12 students.

Goal 1: Facilitate P–16 STEM Education Outreach

Identify campus STEM P–16 outreach activities.

I-STEM has identified STEM outreach coordinators from campus colleges and units and holds regular meetings with them. The I-STEM-News listserv facilitates communications about outreach seminars, meetings, and working groups, and the I-STEM Affiliates Directory enables collaboration. I-STEM's Externally Funded Projects Directory includes a section devoted to current campus STEM P–16 outreach activities (*online access links available in resources lists on pages 2 and 22*). To improve recruitment and to assess the impact of outreach activities, a newly-created participant database will soon include student participants and their schools.

Partner with state and national organizations.

To ensure that *Illinois* is strategically positioned to promote collaboration and leverage resources that will improve STEM education experiences for P–16 students in the State of Illinois, especially those from underrepresented groups, I-STEM is collaborating with numerous state and national STEM P–16 outreach entities, such as the Science Olympiad.

Science Olympiad. *Illinois* hosted the State Science Olympiad in April 2009, with 1800 student participants representing all regions of the State of Illinois. In 2010, *Illinois* will host both the State and the National Science Olympiad, with more than 5000 high school students, their teachers, and families attending. A partnership agreement is being forged between this campus and the National Science Olympiad to increase *Illinois* involvement in the Olympiad.



Illinois hosted the State Science Olympiad in April 2009, with 1800 student participants representing all regions of the State of Illinois.



Clockwise from above left: Students celebrate receiving their medals at Science Olympiad closing ceremony. Top right: Science Olympiad contestant tinkers with exhibit during competition. Bottom right: Science Olympiad participant operates remote in *Illinois* lab. Opposite page (p. 4): Student experiences Veterinary Medicine lab during the State Science Olympiad tour of campus.



Illinois Math and Science Academy (IMSA). Continuing to develop its partnership with IMSA, I-STEM collaborated with the Chicago organization on five federal grant applications, hosted student exchanges with the College Engineering and University High School, and arranged for student/faculty research experiences in Engineering and the College of Liberal Arts and Sciences. I-STEM Director Lizanne DeStefano is a member of the IMSA “Dream Team” Advisory Committee appointed to develop a strategic plan for IMSA’s downstate expansion.

BIO 2010 and the iBIO Institute. The BIO International Convention, the largest global event for the biotechnology industry, will be held May 2010 in Chicago. Paralleling the convention is an educational program which is being organized by iBIO, the Illinois affiliate of BIO, and by iBIO’s educational arm, the iBIO Institute. I-STEM is partnering with the iBIO Institute to plan a lasting P–20 BIO educational legacy for the State of Illinois as the BIO 2010 host site.

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I-STEM has begun to systematically collect standardized data across programs on participant and school demographics, satisfaction, and impact on STEM interest and content knowledge that can be aggregated to represent campus-level impact.

Evaluate P–16 STEM outreach activities.

Illinois hosts a variety of STEM P–16 outreach activities sponsored by individual faculty, units, or colleges. Prior to the advent of I-STEM, these activities were neither catalogued nor evaluated. To improve program impact, I-STEM has begun to systematically collect standardized data across programs on participant and school demographics, satisfaction, and impact on STEM interest and content knowledge that can be aggregated to represent campus-level impact. These data can then be used to ensure that *Illinois’* STEM outreach activities are easily accessed by families and educators, extend across all grade levels, align with local school needs, and attract demographically diverse participants. Table 1 below lists P–16 outreach programs I-STEM now evaluates.



Above: G.A.M.E.S. summer camp participants involved in hands-on activities in an *Illinois* lab.



Illinois science educators participate in hands-on activity during EnLiST professional development.

Table 1: P–16 Outreach Programs Evaluated by I-STEM

Program	Principal Investigator(s)
G.A.M.E.S.: Girls Adventures in Mathematics, Engineering & Science	Susan Larson, Women in Engineering
Nano-CEMMS: Center for Nanoscale Chemical-Electrical-Mechanical Manufacturing Systems: K–12 Education Programs	Placid Ferreira, Engineering John Rogers, Engineering
Urban Schools Initiative	Science Olympiad National Organization



Work with STEM P–16 partners and campus STEM demonstration sites.

To materially define I-STEM’s mission to identify and coordinate P–16 STEM outreach activities, the campus has established a goal that 100 percent of local elementary, middle, and secondary school students will be reached annually through STEM outreach from our campus. To facilitate this effort, an engaging set of outreach activities is being developed, spanning all age ranges and demographic groups. Increased program development at demonstration sites will address noted challenges: to increase recruitment of local schools not engaged with STEM outreach and to boost outreach activities for primary and middle school students.

Booker T. Washington STEM Magnet School. Champaign School District Unit 4’s Booker T. Washington Elementary School is designated to become a STEM magnet program, and federal funds are providing the District with a significant opportunity to construct an entirely new building for this purpose. I-STEM has been involved in year-long planning to develop a curriculum and teacher professional development. To ensure the new building design will support a STEM emphasis, I-STEM has been working with other stakeholders to examine new concepts in curriculum planning and building and classroom design that may support development of an effective and innovative STEM school learning environment.

Pollinarium. Dedicated to increasing awareness and appreciation of pollination as a remarkable ecological partnership, the campus Pollinarium, a facility created by the Department of Entomology, serves as a resource both to the campus and Illinois K–12 students, teachers, and families. I-STEM is helping to develop and expand Beespace, a curriculum unit on bees, to involve Champaign Unit 4 student visits to the Pollinarium. Although second graders are initial targets, all grade levels will eventually become involved.



G.A.M.E.S. The Girls Adventures in Mathematics, Engineering, and Science, an annual week-long camp, offers academically talented middle-school-aged girls an opportunity to explore exciting engineering and scientific fields through demonstrations, classroom presentations, hands-on activities, and contacts with women in these technical fields. I-STEM evaluation found that participating in G.A.M.E.S. helped to change girls’ attitudes about women in engineering and what it means to be an engineer.

Nano-CEMMS K–12 Education Programs. I-STEM’s evaluation of the Center for Nanoscale Chemical-Electrical-Mechanical Manufacturing Systems education program incorporates in-school K–12 programs on nanotechnology-related topics and future nanotechnology career opportunities, and an after-school program for high school students.

Classroom furniture designs and organization schemes under consideration for Champaign Unit 4’s Booker T. Washington STEM Magnet School.

The campus Pollinarium, a facility created by the Department of Entomology, serves as a resource both to the campus and K–12 students, teachers, and families in Illinois.



Increase the number of CPS students who graduate from Illinois in STEM.

To boost the number of Chicago Public School (CPS) students graduating from *Illinois* in STEM fields, this campus strives to engage repeatedly with talented seventh through eleventh grade CPS students via after-school programs, summer camps, mentors, and internships.

Urban Schools Initiative. Last year, *Illinois*' Urban Schools Initiative (USI) expanded to include 17 Chicago Public Schools (CPS) middle and high schools. CPS students attended a full-day symposium on STEM careers, then visited campus for Engineering Open House and the State Science Olympiad. These students will also be offered summer camp scholarships, connected with *Illinois* students as STEM mentors, and encouraged to enroll at *Illinois* upon graduation. I-STEM is also partnering with CPS to discuss creation of a STEM magnet high school in Chicago.

Research Apprenticeship Program (RAP). This College of Agricultural, Consumer, and Environmental Sciences summer research program is receiving recognition for its success in increasing the number of high school students from under-served and economically disadvantaged groups attending *Illinois* and majoring in STEM fields. It provides a multi-year opportunity to participate in research and STEM career pathways awareness activities.

Increase external funding for P–16 STEM education and outreach.

To establish an adequate, sustainable campus funding base of \$2 million for STEM education outreach, I-STEM has participated in submission of more than 30 external funding proposals for P–16 STEM education and outreach. This totals approximately \$22 million in requested funds since I-STEM's January 2009 inception. Efforts are also being made to centralize funds awarded to campus by NSF's Education and Human Resources Directorate (approximately 15% of direct costs) to support a sustainable P–16 STEM education outreach program.



Students experimenting with hands-on exhibit at *Illinois*' 2009 Engineering Open House.

Via the Urban Schools Initiative, Chicago Public Schools students attended a full-day symposium on STEM careers, then visited campus for Engineering Open House and the State Science Olympiad.





I-STEM is partnering with campus projects, such as NSF-funded Math/Science Partnerships, to improve the quality of STEM teacher training and professional development.

Goal 2: Improve STEM Teacher Training and Professional Development Quality

Increase the number and quality of STEM teachers who graduate from Illinois.

I-STEM is working to double the number of STEM teachers who graduate from *Illinois*, improve their retention in the field, and increase their impact on student performance. To this end, I-STEM works with a number of organizations, such as SMTI, and campus projects, such as MIST (described below), which share this same goal.

APLU/SMTI. A member institution of the Association of Public and Land-grant Universities (APLU), *Illinois* has made significant contributions to its Science and Mathematics Teacher Imperative (SMTI). In January 2010, President Obama named SMTI as one of five public-private initiatives comprising his *Educate to Innovate Campaign for Excellence in STEM Education*. *Illinois*' membership in APLU/SMTI has led to I-STEM's participation in three funded NSF proposal submissions and the development of working relationships with both the Carnegie Foundation and senior staff of NSF's Education and Human Resources Directorate.

I-STEM Director Lizanne DeStefano participated in developing SMTI's Analytic Framework through an NSF-funded Math and Science Partnership Research, Evaluation, and Technical Assistance (MSP-RETA) project, producing ongoing related and significant engagements for I-STEM and the *Illinois* campus in developing and engaging the Framework and in collaborating in the State of Illinois Critical Path Analysis of the STEM workforce.



I-STEM is working to double the number of STEM teachers who graduate from Illinois, improve their retention in the field, and increase their impact on student performance.



Above, right, and opposite page (p. 10): Science teachers perform hands-on activities during summer 2009 professional development at *Illinois*.



Student works with technology in Merit section.

**STEM Majors Volunteering
in Local Schools**

- 78 in 2008–2009
- 300 by 2009–2012

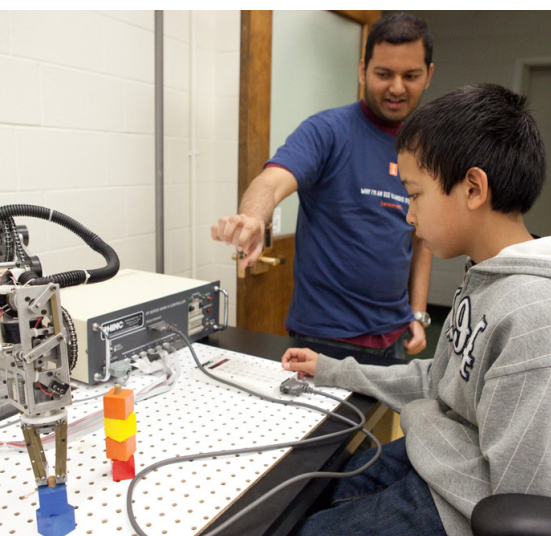


A group of Merit students collaborating on a worksheet.

Merit/MIST. I-STEM is working with the NSF-funded Merit/MIST program in the Chemistry, Math, and Integrative Biology Departments to encourage undeclared majors to consider STEM education careers. Freshman MIST participants receive information about teacher education and opportunities to tutor and gain teaching experience.

Teacher Education Candidates/Student Volunteers. To increase the number of STEM majors volunteering in local schools, I-STEM is creating service learning opportunities in schools and other educational settings, including Science Olympiad, the Orpheum Children’s Museum, and Don Moyer’s Boys and Girls Club. Several departments are interested in increasing their teacher education candidate numbers. The NSF-funded Robert Noyce Teacher Scholarship Program grant co-led by the Curriculum and Instruction and Mathematics Departments offers fellowships to mathematics teacher candidates and encourages freshmen and sophomores to work with K–12 students.

The NSF-funded Robert Noyce Teacher Scholarship Program grant offers mathematics teacher candidate fellowships and encourages freshmen and sophomores to work with K–12 students.



Above and left: *Illinois* volunteers interacting with Science Olympiad students during campus tour.

Evaluate STEM teacher training and professional development projects.

NSF-Funded Initiatives. Several significant STEM teacher training and professional development projects operate at *Illinois*. Two Math and Science Partnership grants provide teacher leadership training. ICLCS: Institute for Chemistry Literacy through Computational Science trains teachers to use virtual tools for teaching chemistry concepts. EnLiST: Entrepreneurial Leadership in STEM Teaching & Learning works to develop entrepreneurial skills for teacher leaders in physics and chemistry. The Merit/MIST program also offers Summer Teacher Workshops to introduce high school and community college math, biology, and chemistry teachers to MERIT program structure and teaching strategies. Engineering’s Nano-CEMMS Center offers both summer workshops to help teachers learn how scientists and engineers work to manipulate matter at the molecular level and online teaching modules for classroom use.

I-STEM supports these activities by providing on-campus evaluation services, ensuring important continuity and cross-fertilization opportunities among the initiatives; it also assures the engagement of state-of-the art STEM program evaluation models, both on-campus and in coordination with external evaluators (see Table 2 below).

Table 2: Teacher Development Programs Evaluated by I-STEM

Program	Principal Investigator(s)
EnLiST: Entrepreneurial Leadership in STEM Teaching & Learning	Mats Selen, Physics Patricia Shapley, Chemistry Fouad Abd-El-Khalick, Curriculum & Instruction Raymond Price, Engineering
ICLCS: Institute for Chemistry Literacy through Computational Science	Thomas Dunning, Chemistry and NCSA
MIST: Merit-Based Immersion for Students & Teachers: Teaching Careers & Summer Teacher Workshops	James Lisy, Chemistry
Nano-CEMMS: Center for Nanoscale Chemical-Electrical-Mechanical Manufacturing Systems: Teacher Institutes	Placid Ferreira, Engineering John Rogers, Engineering

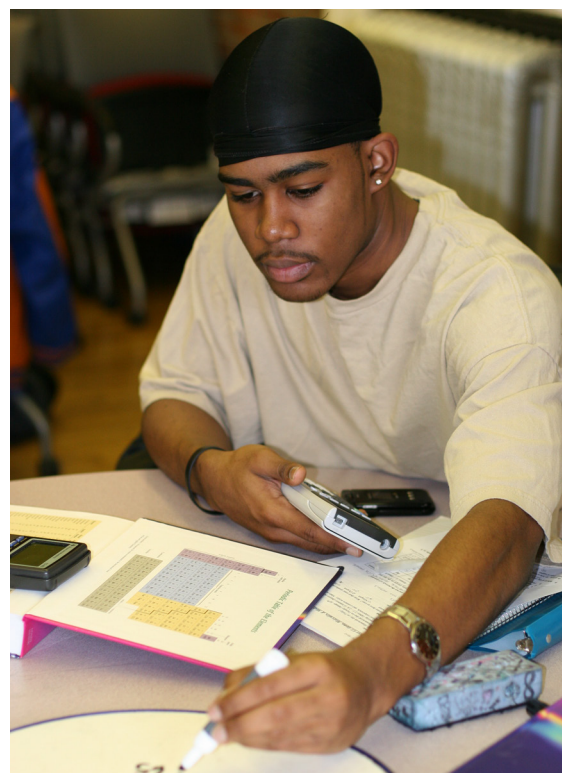


Science teacher completes hands-on project during EnLiST’s summer 2009 professional development workshop.

Externally Funded Campus Research Experiences for Teachers	
2008–2009	4
2009–2010	8



Above and right: Students completing problems during MIST Merit sections.





I-STEM is working to institutionalize a comprehensive, high-quality continuum of professional development for STEM teachers that includes induction and mentoring, graduate disciplinary coursework and degree options, research experiences, and leadership development.

Coordinate and strengthen campus STEM teacher professional development.

I-STEM is working to institutionalize a comprehensive, high-quality continuum of professional development for STEM teachers, including induction and mentoring, graduate disciplinary coursework and degree options, research experiences, and leadership development leading to improved STEM teacher retention, reduced out-of-field teaching, and increased student performance in target districts.

To coordinate across campus STEM teacher development programs, I-STEM has begun a participant and school database for recruiting and evaluation. Related I-STEM activities involve the creation of a logical sequence of professional development experiences across existing programs and strategically targeting high-need districts/ regions to train enough teachers to improve retention and student performance. A comprehensive listing of STEM teacher professional development options is being developed and posted on the I-STEM website, and campus stakeholders are listed in the I-STEM Affiliates Directory (*online access links available in resources lists on pages 2 and 22*).



STEM teachers collaborating during a MIST (Merit-Based Immersion for Students and Teachers) summer 2009 professional development workshop.




Increase external funding for teacher preparation and professional development.

To sustain and institutionalize teacher preparation and professional development programs, I-STEM has assisted with several campus STEM teacher development proposals to NSF and has recommended that new proposals involving STEM teacher professional development incorporate existing campus teacher development programs into them. Also, K–12 school districts have been encouraged to take advantage of campus professional development resources. Campus units are responding to the need by increasing the number of funded Campus Research Experiences for Teacher programs included in large research projects and labs from four in FY2009 to eight in FY2010.



I-STEM has assisted with several campus STEM teacher development proposals to NSF and has recommended that new proposals involving STEM teacher professional development incorporate existing campus teacher development programs into them.

MIST (Merit-Based Immersion for Students and Teachers) summer 2009 professional development workshop for STEM teachers from the State of Illinois.



I-STEM is working to promote our students' success in STEM fields through the creation of accessible and effective undergraduate and graduate STEM programs and engaging research experiences.

Goal 3: Foster Undergraduate and Graduate STEM Education Reform

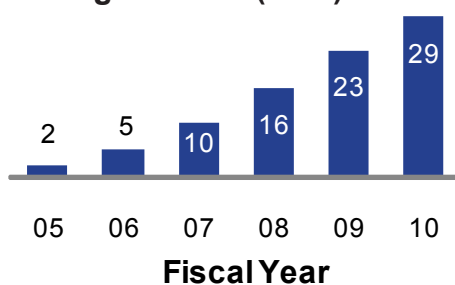
Improve undergraduate STEM courses to increase accessibility, engagement, and success.

To reduce attrition and increase student performance in introductory STEM courses and increase graduation rates for STEM majors, especially for students from traditionally underrepresented groups, I-STEM has begun to identify and coordinate campus undergraduate STEM educational reform activities. Faculty meetings address research findings, best practices, and effective pedagogy and models in STEM teaching and learning, especially around increasing diversity and performance of underrepresented groups. The I-STEM Undergraduate and Graduate Education Working Group, with invited representatives from all STEM departments, meets periodically and is facilitated by the I-STEM Affiliates Directory (*online access links available on pages 2 and 22*). Helping units understand student data patterns of performance and reasons for choosing/leaving STEM majors and impacts of reform on student performance is also an I-STEM priority.

I-STEM Chancellor's Fellow Anne Baranger, associate professor of Chemistry, coordinates the I-STEM Undergraduate and Graduate Education Working Group, focusing its efforts on curricular reform. She is also working with Chemistry to improve the undergraduate curriculum.

Campus units are also steadily increasing their funded Research Experiences for Undergraduates (see Figure 1 at the right).

Figure 1: Active NSF-Funded Research Experiences for Undergraduates (REU) Awards



Evaluate and analyze undergraduate and graduate STEM education reform projects.

Another I-STEM activity is to analyze campus STEM academic programs to identify strengths and gaps and to serve as the basis for developing effective, scalable, and sustainable STEM education to bridge and support models for the campus, including exploring the use of on-line courses as a means of bridging with high schools and community colleges. As STEM departments at *Illinois* make formal commitments to improving their academic offerings, both campus-funded and externally funded reform projects have been engaged, and I-STEM has been invited to conduct evaluations of several of these projects, listed in Table 3, which follows on page 18.



Student enjoying MIST Merit section.

I-STEM has begun to identify and coordinate campus undergraduate STEM educational reform activities. Meetings with faculty address research findings, best practices, and effective pedagogy and models in STEM teaching and learning.





Above: Merit section students collaborate to solve problems related to lecture topics.

Chemistry, Mathematics, and Integrative Biology co-sponsor the MIST (Merit-Based Immersion for Students and Teachers) program, which encourages undeclared students to declare STEM majors.



iFoundry students work together during wall climb at fall start-up event.

Engineering Climate Study. Commissioned by the College of Engineering, I-STEM conducted this study to understand undergraduate and graduate students' experiences in the College, as well as to better understand barriers and opportunities to increasing recruitment and retention at all levels.

Nano-CEMMS. Since the inception of the Center for Nanoscale Chemical-Electrical-Mechanical Manufacturing Systems in 2003, Lizanne DeStefano has played a formative role in the design and evaluation of its education programs. This collaboration is now integrated into I-STEM activity and includes evaluation of multi-faceted Nano-CEMMS components: two summer research programs for undergraduates, an undergraduate scholarship program, graduate student enrichment programs, the promotion of educational collaboration among various research projects involved, and professional development, including foreign training opportunities.

Develop support programs to improve recruitment, retention, and graduation of STEM students.

Learning communities, and bridge and mentoring programs, can all improve recruitment, retention, and matriculation of students in STEM fields. However, they are often not well coordinated or sustainable. Some lack academic support and advising or support beyond the freshman year. In addition, students are often unaware of supports, needed qualifications, or of how to access services. Successful *Illinois* programs, such as MIST and iFoundry (described below) could serve as campus models for increasing student support.

MIST: Merit-Based Immersion for Students and Teachers.

Co-sponsored by the Chemistry, Mathematics, and Integrative Biology Departments, the MIST program targets undeclared students and encourages them to declare STEM majors.

iFoundry. The Illinois Foundry for Innovation in Engineering Education is a College of Engineering curriculum incubator that transforms undergraduate education for engineers. iFoundry prepares undergraduate students for the challenges of a global, creative era through conceptual and philosophical planning, collaborative organization and experiences, shared technology, and other systems innovations. I-STEM participates in iFoundry's planning, development, and formative and summative evaluation processes.

Table 3: Undergraduate/Graduate STEM Programs Developed, Studied, and Evaluated by I-STEM

Program	Principal Investigator(s)
Engineering Climate Study	Lizanne DeStefano, I-STEM & Educational Psychology
iFoundry: Illinois Foundry for Innovation in Engineering Education	David Goldberg, Engineering Raymond Price, Engineering
MIST: Merit-Based Immersion for Students & Teachers: Undergraduate Courses	James Lisy, Chemistry
Nano-CEMMS: Center for Nanoscale Chemical-Electrical-Mechanical Manufacturing Systems: Undergraduate & Graduate Programs	Placid Ferreira, Engineering John Rogers, Engineering

Increase external funding to improve undergraduate and graduate STEM education.

To ensure adequate funding to support undergraduate and graduate STEM education reform for consistent, sustained, high-impact programming, I-STEM is encouraging units to apply for educational improvement resources from more than 40 programs offered by major external funders; the 2009 submissions summarized in Table 4 below are valued at \$16.275 million. To assist faculty, I-STEM is



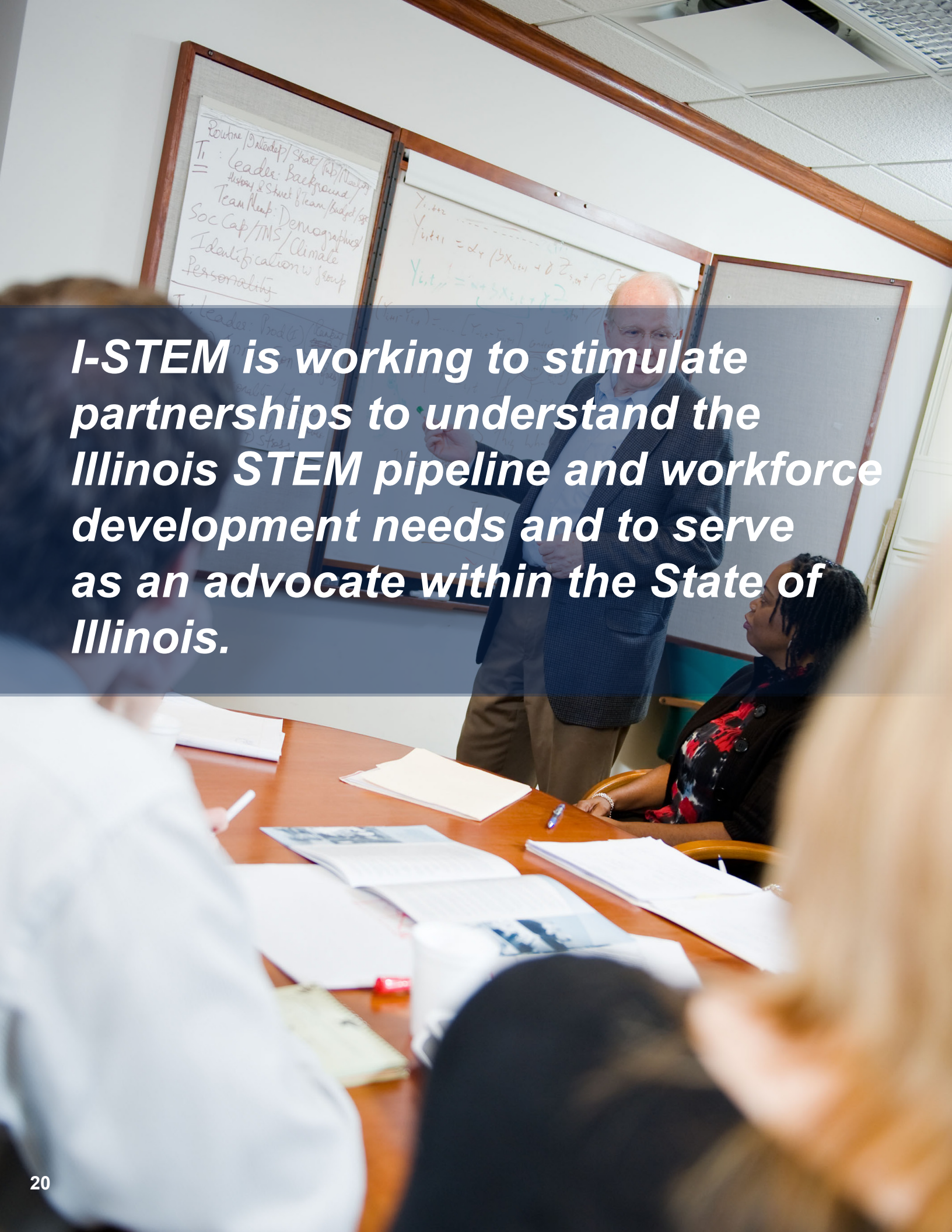
providing a variety of supports, such as mechanisms developed to apprise STEM faculty of funding opportunities: frequent workshops, meetings, and numerous online resources, including an extensive directory of current external funding opportunities, a calendar, and the I-STEM-NEWS listserv to update faculty on upcoming funding deadlines; plus a bibliography of STEM publications for grantwriting use; and the I-STEM Affiliates Directory to facilitate collaboration across units (online access links available in resources lists on pages 2 and 22).



Mechanisms have been developed to apprise STEM faculty of funding opportunities: frequent workshops and meetings and numerous online resources.

Table 4: Undergraduate/Graduate STEM Education Funding Opportunities Targeted in 2009

Funder	Program	Proposals Submitted in 2009	Status (January 2010)
National Science Foundation	Course Curriculum and Laboratory Improvement (CCLI)	2	2 pending
	Science Master’s Program (SMP)	1	1 awarded
	Louis B Stokes Alliances for Minority Participation (LSAMP) and LSAMP Bridge to the Doctorate	none	1 awarded (alliance member)
	Science, Technology, Engineering and Mathematics Talent Expansion Program (STEP)	1	1 awarded 2 active
	Research Opportunities for Undergraduates (REU) Supplement and Site Programs	6	6 awarded 29 active
	Integrative Graduate Research Training (IGERT)	2	1 awarded
	Innovative Technology Experiences for Students & Teachers (ITEST)	1	1 pending
	Robert Noyce Teacher Scholarship Program (Noyce)	2	1 awarded
	Partnerships for International Research and Education (PIRE)	1	not funded
US Department of Education	Fund for the Improvement of Postsecondary Education (FIPSE)	2	2 awarded
	Educational Research Grants, Institute for Education Sciences (IES)	4	3 awarded
	Postdoctoral Training Grants, Institute for Education Sciences (IES)	2	1 awarded
	Graduate Assistance in Areas of National Need (GAANN)	2	2 awarded 3 active
National Institutes of Health	NIH Challenge Grants in Science Education	1	1 awarded
	Science Education Partnership (SEPA)	1	1 awarded
Private Funders	Howard Hughes Medical Institute (HHMI) Science Education Grants	1	1 pending

A man in a dark suit and glasses stands in a meeting room, pointing at a whiteboard. The whiteboard contains handwritten notes and mathematical equations. One equation is $Y_{it+1} = \alpha + \beta X_{it+1} + \delta Z_{it+1} + \rho \epsilon_{it}$. Another equation is $Y_{it+1} = \alpha + \beta X_{it+1} + \delta Z_{it+1} + \rho \epsilon_{it}$. The notes on the whiteboard include: "Routine / Interdep / Strat / Pub / Mentoring", "T_i : Leader: Background", "History & Struct of Team / Budget / Org", "Team Memb: Demographics", "Soc Cap / TMS / Climate", "Identification w Group", and "Personality". In the foreground, several people are seated around a wooden conference table, looking towards the man at the whiteboard. The room has a drop ceiling and a window with blinds.

I-STEM is working to stimulate partnerships to understand the Illinois STEM pipeline and workforce development needs and to serve as an advocate within the State of Illinois.

Goal 4: Shape Policy and Advocate for STEM Education

Network to advocate for funding, incentives, and programmatic support for STEM education.

Although progress toward this goal was initially slowed by early 2009 changes in the Illinois governor's office and ongoing economic conditions in the state, I-STEM efforts have remained steady, and outcomes are now accelerating.

STEM Workforce Development.

I-STEM co-hosted a statewide meeting on STEM outreach in May 2009 in cooperation with the Department of Commerce and Economic Opportunity (DCEO). School administrators, state agency representatives, community college and university administrators, and industry representatives from around the State of Illinois attended to explore STEM collaborations. This meeting laid the foundation for subsequent P-20 Council and Race to the Top activities.



State P-20 Council. In January 2010, the Governor of the State of Illinois invited Dr. DeStefano to serve on the State of Illinois P-20 Council. The purpose of this legislatively specified body is to study and make recommendations concerning education at all levels to avoid fragmentation of policies, promote improved teaching and learning, and continue to cultivate and demonstrate strong accountability and efficiency. I-STEM's work with the P-20 Council is especially intended to ensure Illinois' effective coordination with national priorities, including President Obama's *Educate to Innovate* campaign, to improve the participation and performance of Illinois students in STEM (link to Governor's announcement: <http://www.illinois.gov/PressReleases/ShowPressRelease.cfm?SubjectID=3&RecNum=8071>).

Race to the Top. I-STEM was part of the statewide team which compiled the State of Illinois' *Race to the Top* application (link: <http://www.isbe.state.il.us/racetothetop/default.htm>). In March 2010, the State was named one of 16 finalists in this high-stakes competition. Illinois' *Race to the Top* strategy involves a common vision for STEM education that includes strong engineering and technical components and focuses on authentic real-world problems. The state set targets of 55% of students participating in STEM-related programs of study by 2013-14. *Illinois* is working with the State to establish STEM Learning Exchanges among business, post-secondary institutions, and K-12 schools to expand STEM education opportunities. We are also involved in the creation of a statewide Learning and Performance Management System using cloud-based computing.

Illinois STEM Workforce Development Meeting Participants, May 2009

- Chicagoland Chamber of Commerce
- Community Colleges
- Department of Commerce & Economic Opportunity
- Governor's Office
- Illinois Board of Higher Education
- Illinois Business Higher Education Roundtable
- Illinois Community College Board
- Illinois Educational Research Council
- Illinois Math & Science Academy
- Illinois State Board of Education
- Illinois State University
- K-12 Education
- Northern Illinois University
- Parkland College
- University of Illinois at Urbana-Champaign

I-STEM's work with the P-20 Council is especially intended to ensure Illinois' effective coordination with national priorities, including the Educate to Innovate campaign, to improve Illinois students' participation and performance in STEM.



Since January 2009, I-STEM staff have been collecting information on national and state trends in STEM workforce needs, teacher shortages, and the status of the STEM pipeline and mainline.

Document trends and needs in Illinois' STEM teaching and learning, teacher preparation, workforce, and STEM pipeline and mainline.

Illinois Critical Path Analysis.

Since January 2009, I-STEM staff have been collecting information on national and state trends in STEM workforce needs, teacher shortages, and the status of the STEM pipeline and mainline. In 2009, I-STEM secured \$200K from Caterpillar Foundation to fund the Illinois Critical Path Analysis.

In June 2009, the first meeting was held with representatives from the Illinois State Board of Education, the Illinois Board of Higher Education, and Illinois staff to plan for the Illinois Critical Path Analysis using the SMTI model,

as discussed earlier. Representatives of Abbott, Caterpillar, State Farm, Boeing, and John Deere have been invited to serve on the Task Force to conduct the analysis. I-STEM will eventually produce and disseminate a white paper on this topic.



Evaluate and analyze STEM policies.

I-STEM participates in a variety of national projects that examine broad policy initiatives affecting STEM education at all levels. In some cases, this includes formal evaluation of policies and initiatives. In 2009, this included a study of the National Assessment of Education Progress (NAEP) Mathematics Assessment and support for the development of a P–20 Council (see Table 5 below).

Table 5: I-STEM Policy/Advocacy Projects

Project	Principal Investigator(s)
NAEP: National Assessment of Educational Progress: Math Accessibility Study	Lizanne DeStefano, I-STEM & Educational Psychology
Illinois P–20 Council	Lizanne DeStefano, I-STEM



I-STEM Website Funding Resources

- **Directory of Externally-Funded STEM Education Projects**
url: <http://www.istem.illinois.edu/stemed/stemed.html>
- **STEM Education External Funding Opportunities, by I-STEM Goal**
url: <http://www.istem.illinois.edu/funding/fundingopps.html>
- **Upcoming Funding Deadlines**
url: <http://www.istem.illinois.edu/funding/upcomingdeadlines.html>
- **STEM Education Annotated Bibliography**
url: <http://www.istem.illinois.edu/resources/resources.html#bibliography>



I-STEM's analysis and reporting activities include identifying and cataloging of Illinois' resources and relationships with external funding programs. I-STEM has created a picture of existing external investments already active on this campus.

Identify constituent projects for STEM education reform at Illinois.

I-STEM's analysis and reporting activities include identifying and cataloging of *Illinois'* resources and relationships with external funding programs. Well-positioned to create a campus-wide view of existing and available resources, I-STEM has created a picture of existing external investments already active on this campus.

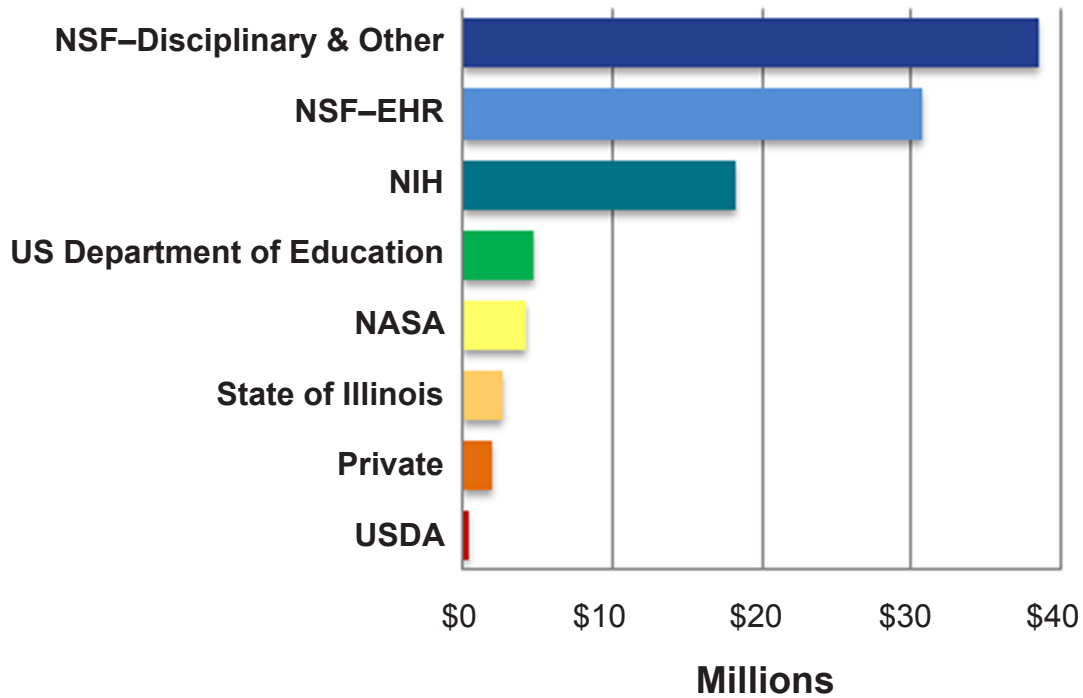
**FY 2010 STEM Education
Funding at Illinois
= \$101.5 Million**

The estimated total of more than \$101 million in active investments spans five federal agencies, including the National Science Foundation (both NSF's Education and Human Resources Directorate and its disciplinary directorates), the US Department of Education (including the Institute of Education Sciences and other department offices), the National Institutes of Health, the National Aeronautics and Space Administration, and the US Department of Agriculture. The State of Illinois supports campus STEM education projects through the Illinois State Board of Education and the Illinois Board of Higher Education. Private and corporate support for STEM education projects include, notably, Sloan Foundation, Caterpillar Foundation, Hewlett Packard Co., Ford Foundation, the National 4-H Council, Abbott Laboratories, John Deere Foundation, Motorola Foundation, Shell Oil Company, and ExxonMobil. Figure 2 (see page 24) provides a more descriptive view of these funding sources.

This external investment supports substantial STEM education activities across eight academic units on our campus and at the campus administration level. Projects supported within these units include STEM P-16 outreach, teacher training and professional development, undergraduate and graduate disciplinary training programs, individual graduate and postdoctoral fellowship support, and STEM education research and evaluation. Figure 3 (see page 25) describes this distribution of external investment across campus units.

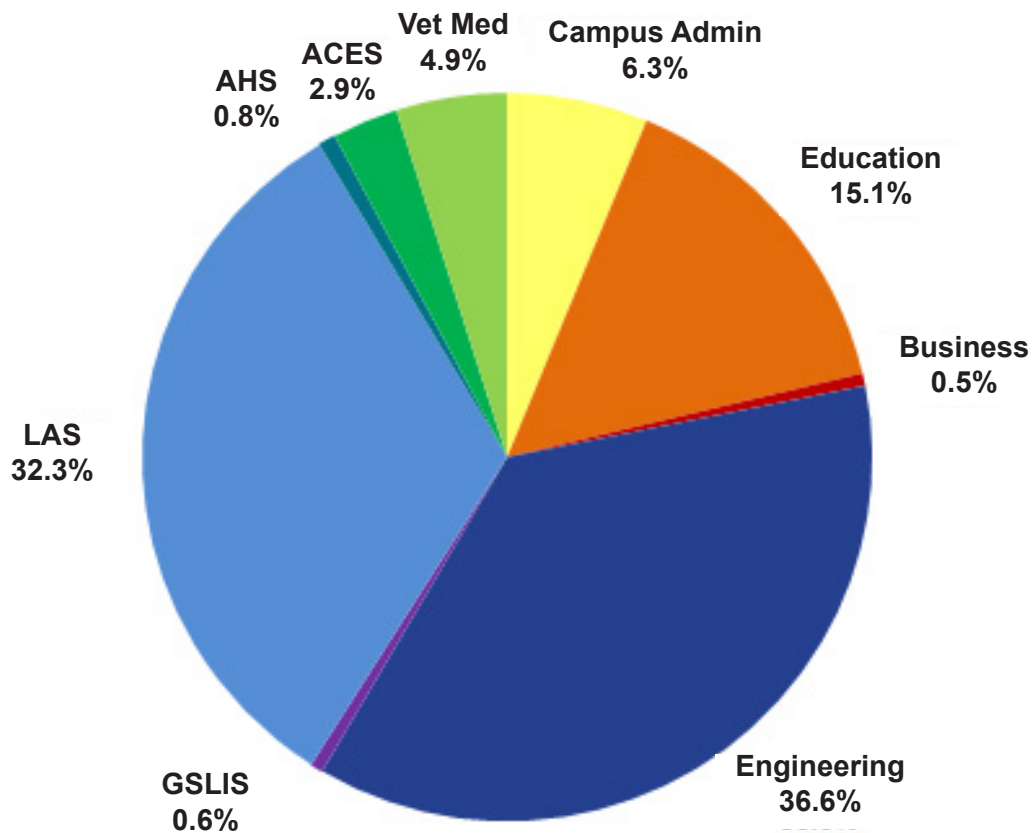


Figure 2: Active External Investment in STEM Education for Fiscal Year 2010, by Funder



FUNDER	CURRENT INVESTMENT
National Science Foundation—Disciplinary Directorates & Other Offices (NSF-Disciplinary)	\$38,482,592
National Science Foundation—Education & Human Resources Directorate (NSF-EHR)	\$30,685,408
National Institutes of Health (NIH)	\$18,285,409
US Department of Education (DoED)	\$4,765,625
National Aeronautics and Space Administration (NASA)	\$4,229,107
State of Illinois Agencies (State of Illinois)	\$2,618,683
Foundations and Corporate Support (Private)	\$1,990,322
US Department of Agriculture (USDA)	\$487,000
FY10 STEM Education Projects at Illinois: Total Active Investment	\$101,544,145

Figure 3: Active External Investment in STEM Education for Fiscal Year 2010, by Campus Unit



CAMPUS UNIT	CURRENT INVESTMENT
Campus/University Administration (Campus Admin)	\$6,401,316
Education	\$15,403,095
Business	\$555,317
Engineering	\$37,453,278
Library and Information Science (GSLIS)	\$569,154
Liberal Arts and Sciences (LAS)	\$33,049,185
Applied Health Sciences (AHS)	\$81,734
Agricultural, Consumer and Environmental Sciences (ACES)	\$2,993,268
Veterinary Medicine (Vet Med)	\$5,037,798
FY10 STEM Education Projects at Illinois: Total Active Investment	\$101,544,145



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